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Relationship of Different Forest Floor Layers to Herbage Production

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Herbage production decreases as individual layers and total depth of ponderosa pine forest floor increases. The H layer or total depth of the forest floor accounts for more variation in herbage production than the L or F layers. Management practices which remove only the L and F layers of the forest floor cannot be expected to increase herbage production appreciably.

The forest floor, or the accumulation of organic matter above mineral soil, is important in land management because of its effect on such factors as fire danger, water retention, and herbage production. Normally only the total forest floor has been considered and it has not been determined what influence different individual forest floor layers may have. Three forest floor layers are distinguished: an **L** or litter layer, consisting of unaltered organic matter; an **F** or duff layer, consisting of partly decomposed organic matter; and the **H** or humus layer, consisting for the most part of well decomposed organic matter (Kittredge 1948).

Previous work led us to expect that herbage production would decrease as the total amount of forest floor increased (Wahlenberg et al. 1939, Gaines et al. 1954, Pase 1958, Jameson 1966). To allow more precision in land management prescriptions, however, the study reported here was designed to investigate the relationships between herbage production and the individual layers of a ponderosa pine (Pinus ponderosa Lawson) forest floor.

Study Area

The study was conducted on the Beaver Creek watershed (Worley 1965) in north-central Arizona. Ponderosa pine comprises over 85 percent of the tree cover on the study area, with Gambel oak (Quercus gambelii Nutt.) and alligator juniper (Juniperus deppeana Steud.) occurring as intermingled species. Annual

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precipitation averages 23 inches within this zone. Soils are developed from basalt and volcanic cinders, with surface textures ranging from clay loam to loam.

Important grasses and grasslike plants include blue grama (Bouteloua gracilis (H.B.K.) Lag.), bottlebrush squirreltail (Sitanion hystrix (Nutt.) J. G. Smith), mutton bluegrass (Poa fendleriana (Steud.) Vasey), and sedges (Carex spp.). Principal half-shrubs and forbs are broom snakeweed (Gutierrezia sarothrae (Pursh) Britt. & Rusby), showy goldeneye (Viguiera multiflora (Nutt.) Blake), showy aster (Aster commutatus (Torr. & Gray) Gray), spreading fleabane (Erigeron divergens Torr. & Gray), and western ragweed (Ambrosia psilostachya DC.).

Methods

Ponderosa pine forest floor depths, by individual layers and total, were measured at 228 permanently located timber inventory sample plots. Four measurements were taken within 2 feet of each plot center, one in each "quadrant." These measurements were obtained without compressing the layers. Material from herbaceous plants was not considered part of the forest floor. An average of the four measurements, recorded to the nearest 0.1 inch, was assumed to be representative of forest floor depth, by layers and total, at each of the sample plots.

Herbage production by species was determined by the weight-estimate method (Pechanec and Pickford 1937). A 9.6-square-foot circular plot was centered at each sample plot to measure herbage production.

Herbage production was transformed to logarithms on the basis of preliminary examination and the study data subjected to regression analysis.

Results and Discussion

Herbage production decreased from over 300 to less than 10 pounds per acre as total forest floor accumulations increased from essentially zero depth to over 2.5 inches. This general trend was similar to that found in previous studies.

Sample plots with zero depths of forest floor do not represent nontimbered conditions. There were areas with no measurable accumulation of forest floor throughout the timber stand as a result of uneven stocking. These areas were still influenced by the timber overstory, however, because similar areas with all timber overstory removed produced two to five times more herbage than the areas included in this study (Clary et al. 1966).

Herbage production also decreased as individual layers of forest floor increased. Equations empirically describing relationships between the depth of forest floor in inches (individual layers and total) and logarithm of herbage production in pounds per acre are summarized below:

1. $\text{Log } Y = 2.3691 - 2.0321\ X_L \quad r = 0.42$
2. $\text{Log } Y = 2.4164 - 2.3712\ X_F \quad r = 0.44$
3. $\text{Log } Y = 2.3396 - 1.7655\ X_H \quad r = 0.61$
4. $\text{Log } Y = 2.6001 - 0.8888\ X_T \quad r = 0.58$

Correlations between the **L** or **F** layers and herbage production were significantly smaller (at the 1 percent level) than correlations between the **H** layer or total depth and herbage production. Therefore, a smaller amount of the variation in herbage production, as indicated by r^2, can be accounted for by the **L** and **F** layers than by the **H** layer or total depth. Correlations between the **L** or **F** layer and herbage production were not different; neither were correlations between the **H** layer or total depth of the forest floor and herbage production.

Significant correlation coefficients do not necessarily mean that a cause-and-effect relationship exists. For management recommendations, however, it is of interest that the **H** layer provided a significantly better correlation with herbage production than did either of the upper two layers. This indicates that management practices, such as prescribed burning, that remove only the upper layers of forest floor should not be expected to increase herbage production appreciably (fig. 1).

A, Entire forest floor originally consumed by fire.

B, Only upper forest floor layers originally consumed by fire.

Figure 1.--Herbage production observed 4 years after a prescribed burn in ponderosa pine (Davis et al. 1968).

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